



**National Aeronautics and
Space Administration**

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Interoperable Data Sharing for Diverse Scientific Disciplines

EGU General Assembly 2015

EGU2016-1841

17–22 April 2016

S. Hughes, D. Crichton, S. Martinez, E. Law, S. Hardman

Presented by D. Heather

**Jet Propulsion Laboratory
California Institute of Technology**



Interoperability and Shared Understanding

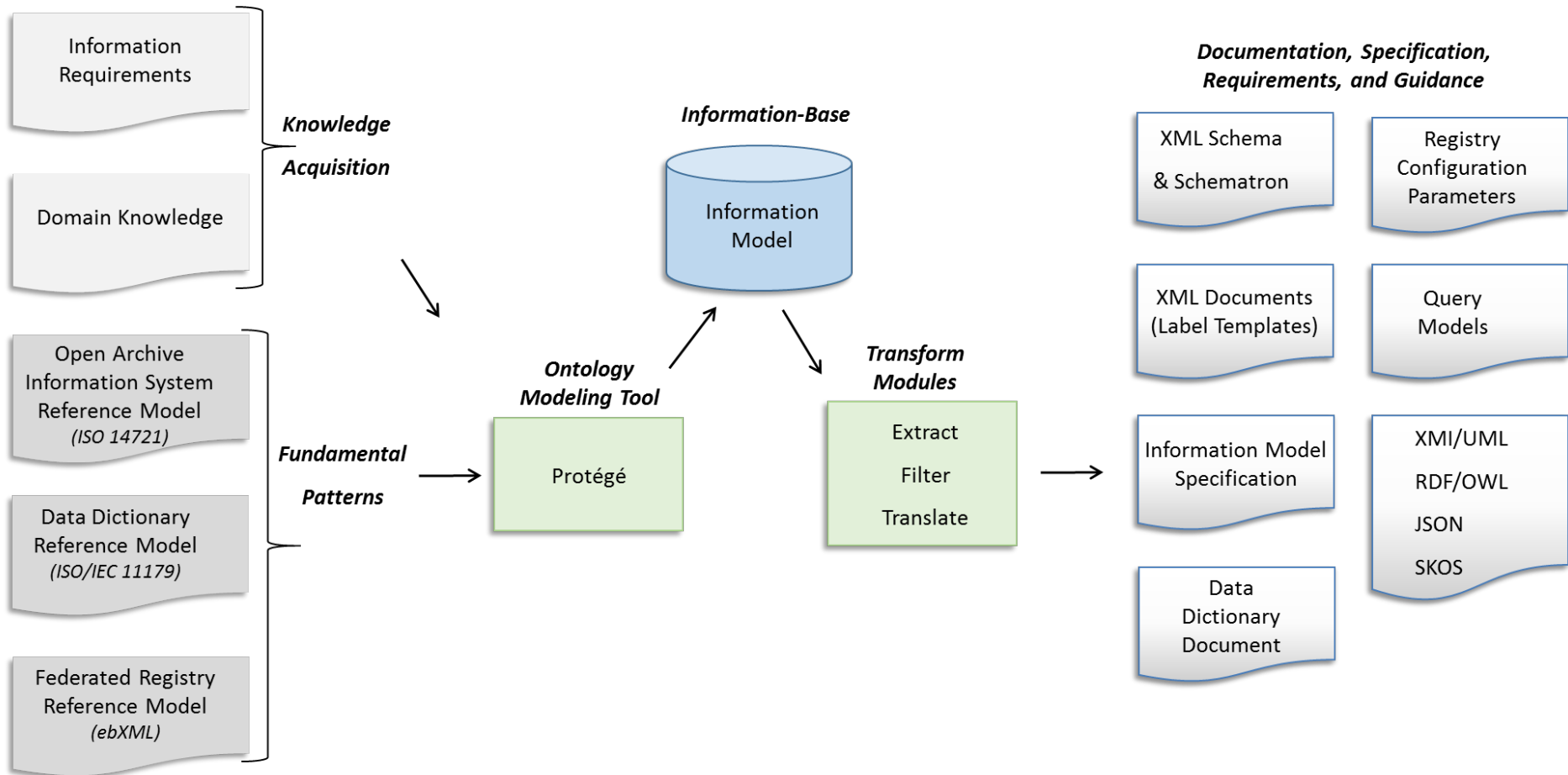
- **For scientific disciplines to interoperate they must be able to exchange information based on a shared understanding.**
- **The shared understanding is captured using a knowledge representation framework.**
 - *The framework uses ontologies to capture discipline knowledge.*
 - *It uses ISO level archive and metadata registry reference models as foundational standards.*
- **The framework promotes agile development of the information system, including adaptive planning, evolutionary development, early delivery, continuous improvement, and rapid and flexible response to change.**
 - *The resulting information model remains independent of the implementation, allowing parallel but separate evolution.*
 - *Allows a multi-level governance of the information model.*



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

The “Cornerstone” Framework





The Information Model

- “An information model is a representation of concepts, relationships, constraints, rules, and operations to specify data semantics for a chosen domain of discourse.” ¹
- It provides a sharable, stable, and organized structure of information requirements or knowledge for the domain context.

¹ Lee, Y. T. 1999. Information Modeling: From Design To Implementation. In Proceedings of the Second World Manufacturing Congress, ed. S. Nahavandi and M. Saadat, 315-321. Canada/Switzerland: International Computer Science Conventions.



The Information Model's Role

	Why	How	What	Who	Where	When
Contextual	Goal List	Process List	Material List	Organisational Unit & Role List	Geographical Locations List	Event List
Conceptual	Goal Relationship	Process Model	Entity Relationship Model	Organisational Unit & Role Relationship Model	Locations Model	Event Model
Logical	Rules Diagram	Process Diagram	Data Model Diagram	Role Relationship Diagram	Locations Diagram	Event Diagram
Physical	Rules Specification	Process Function Specification	Data Entity Specification	Role Specification	Location Specification	Event Specification
Detailed	Rules Details	Process Details	Data Details	Role Details	Location Details	Event Details

Define and manage

Zackman Framework of Enterprise Architecture



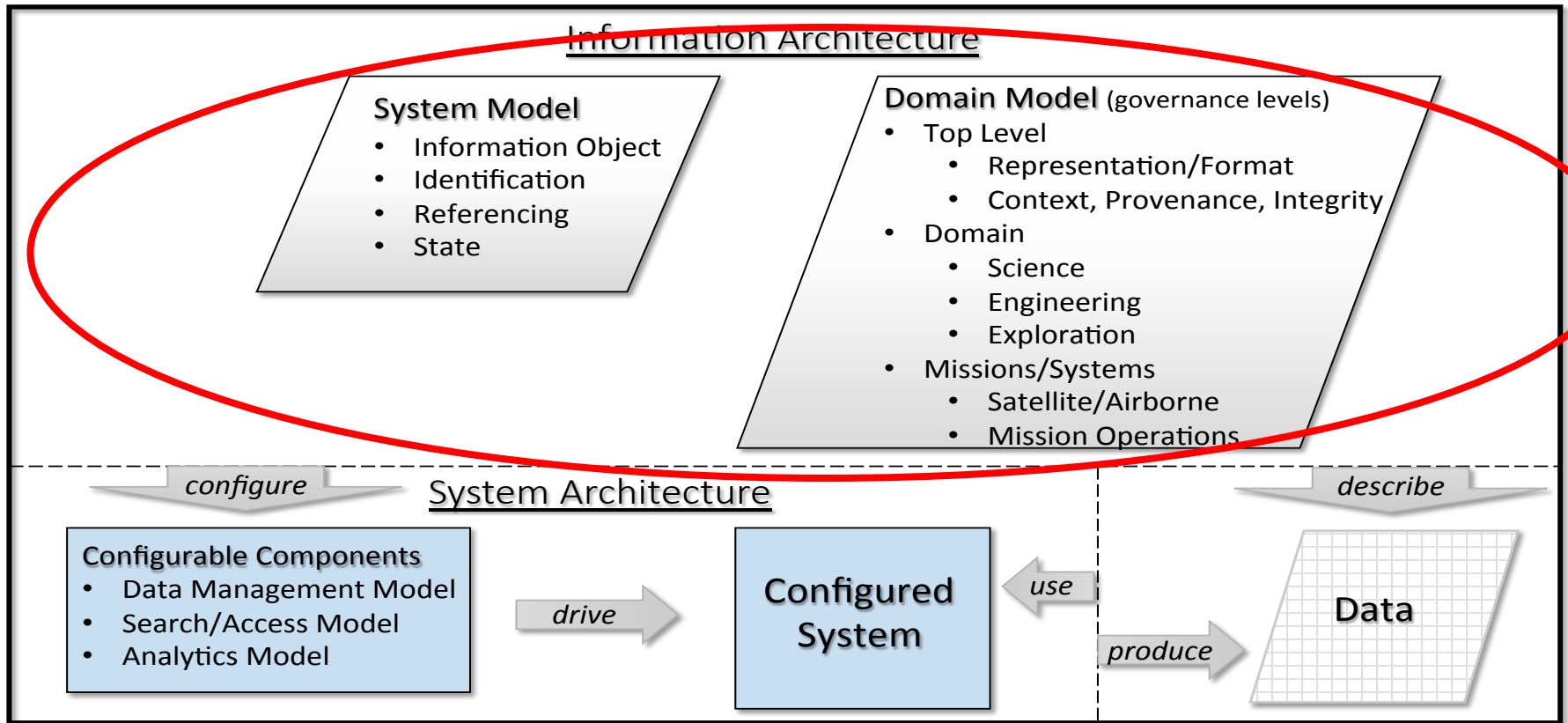
A Common Source for Requirements

- The “sharable, stable, and organized structure of information requirements” provides:
 - *Schemas for data and metadata collection and validation,*
 - *Configuration files for software and services,*
 - *User and system documentation,*
 - *Code snippets for software development.*
 - . . .



Influences All Aspects of the Architecture

Information Model

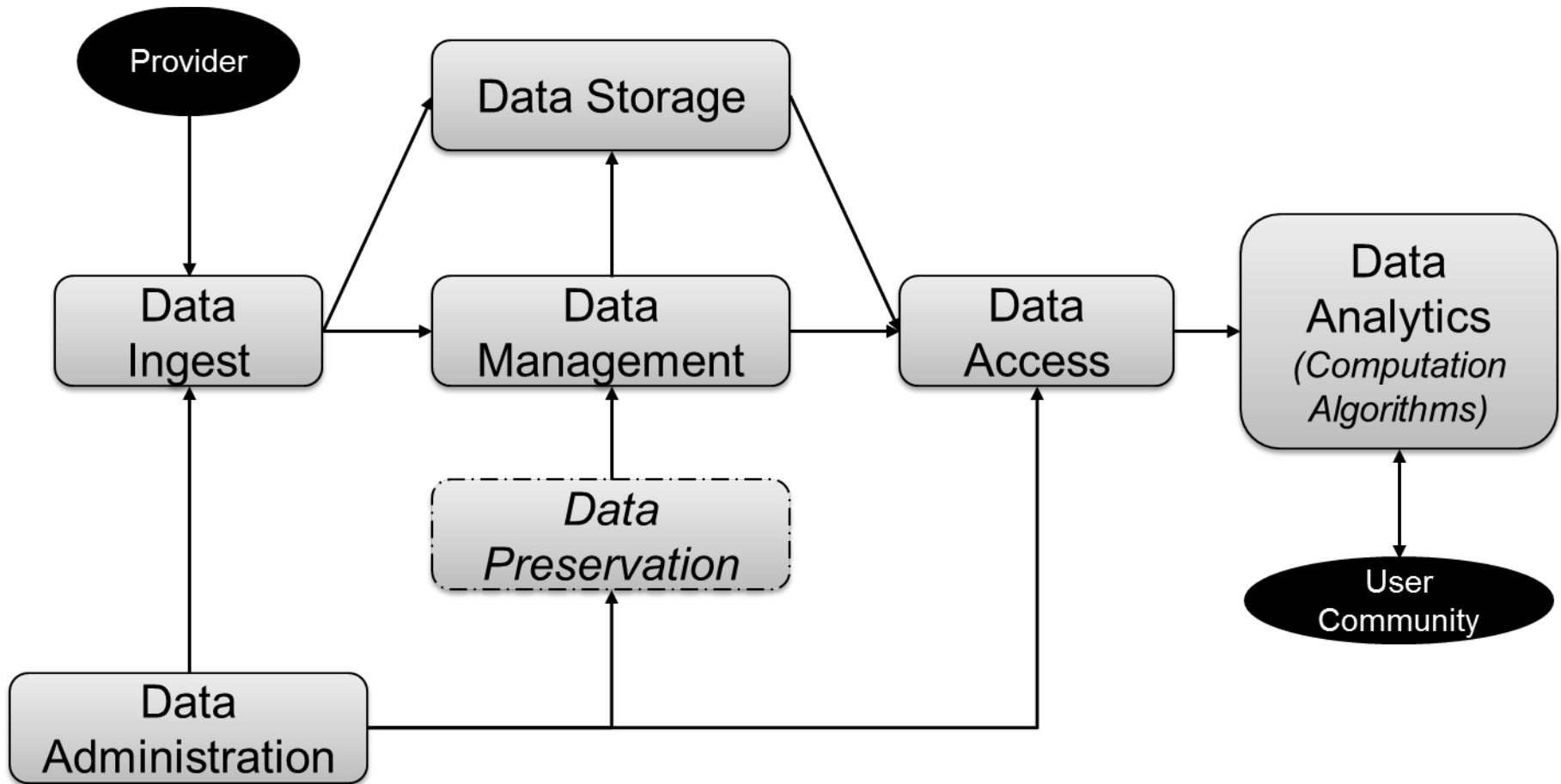




National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

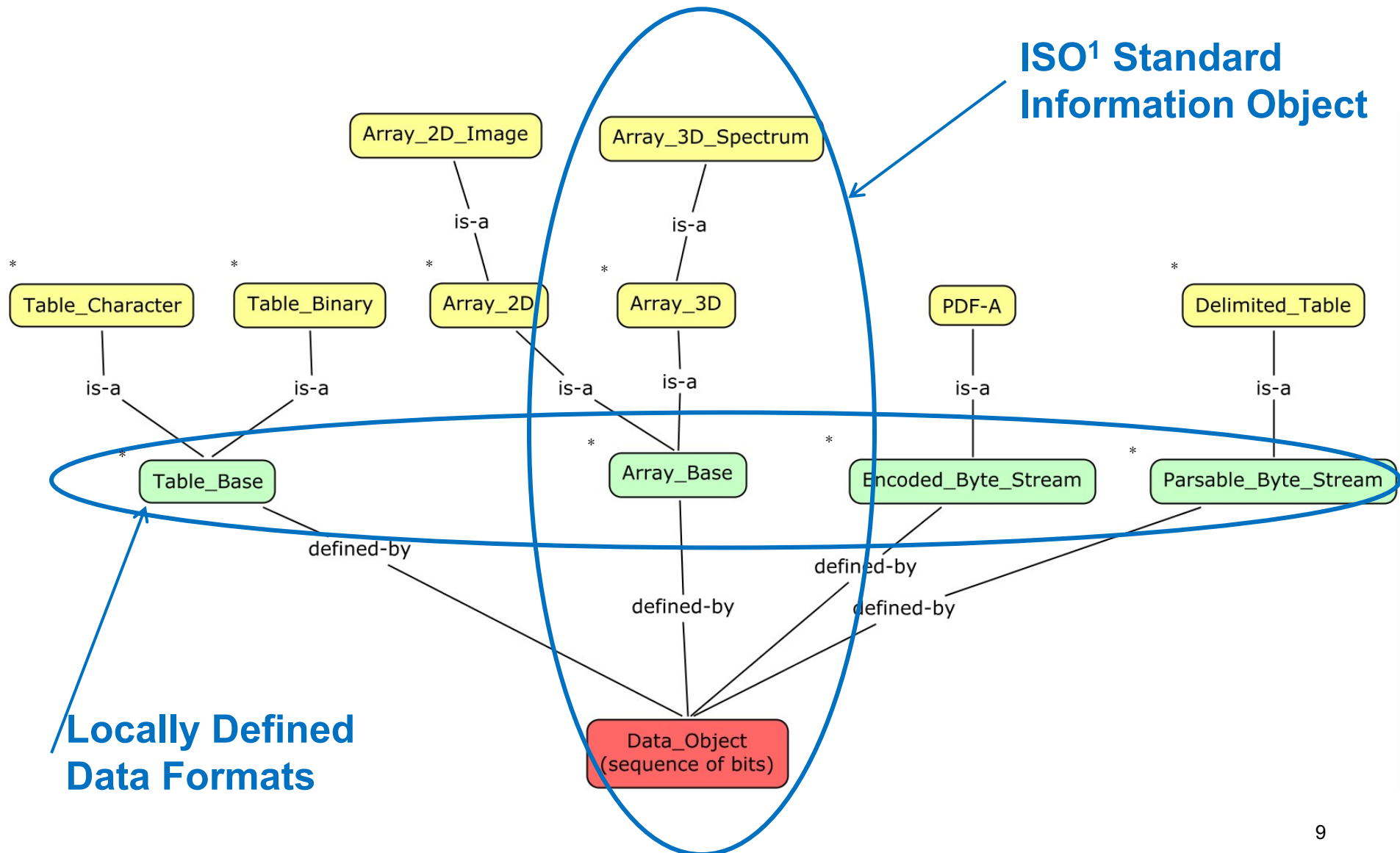
Supports an ISO¹ Standard Functional Architecture



¹ ISO 14721:2003 - Open Archival Information System (OAIS) Reference Model



Correlates ISO Standards with Discipline Requirements



¹ ISO 14721:2003 - Open Archival Information System (OAIS) Reference Model

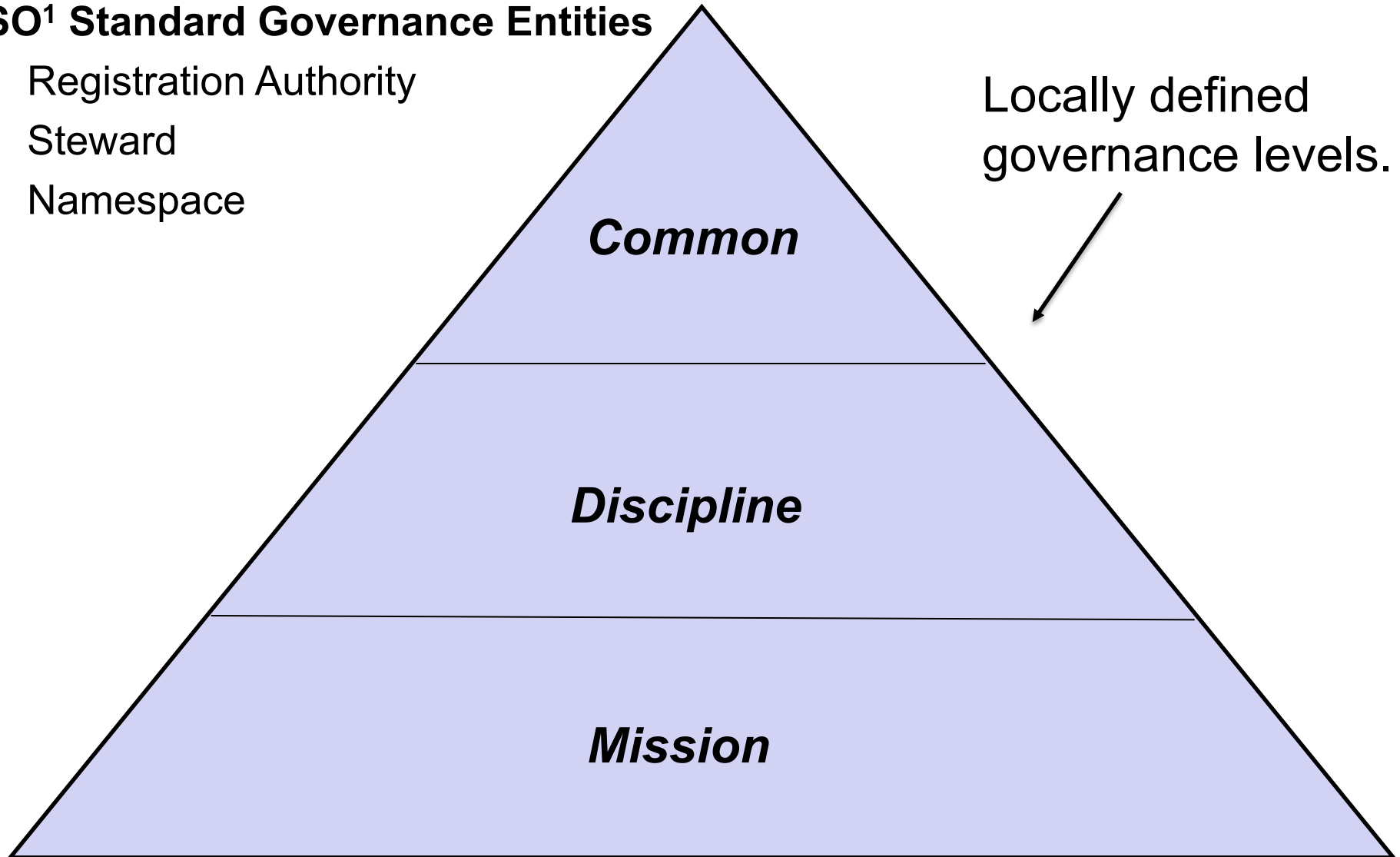


Multi-Level Governance

ISO¹ Standard Governance Entities

- Registration Authority
- Steward
- Namespace

Locally defined
governance levels.



¹ ISO 14721:2003 - Open Archival Information System (OAIS) Reference Model



PDS4: The Next Generation Planetary Data System

- **PDS4 is a PDS-wide project to upgrade from PDS version 3 to version 4 to address many of these challenges**
- **An explicit information architecture**
 - *All PDS data tied to a common model for validation and discovery*
 - *Use of XML, a well-supported international standard, for data product labeling, validation, and searching.*
 - *A hierarchy of data dictionaries built to the ISO 11179 standard, designed to increase flexibility, enable complex searches, and make it easier to share data internationally.*
- **An explicit software/technical architecture**
 - *Distributed services both within PDS and at international partners*
 - *Consistent protocols for access to the data and services*
 - *Deployment of an open source registry infrastructure to track and manage every product in PDS*
 - *A distributed search infrastructure*
 - *Configured by the Information Architecture*



PDS Mission and Vision

- Mission
 - *Facilitate achievement of NASA's planetary science goals by efficiently collecting, archiving, and making accessible digital data and documentation produced by or relevant to NASA's planetary missions, research programs, and data analysis programs.*
- Vision
 - *To gather and preserve the data obtained from exploration of the Solar System by the U.S.*
 - *To facilitate new and exciting discoveries by providing access to and ensuring usability of those data to the worldwide community*
 - *To inspire the public through availability and distribution of the body of knowledge reflected in the PDS data collection*
- PDS is a federation of distributed discipline and service nodes.



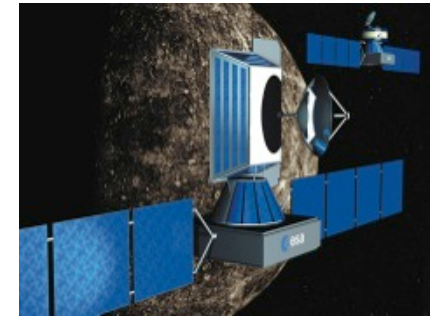
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

International Adoption of PDS4



InSight (NASA)

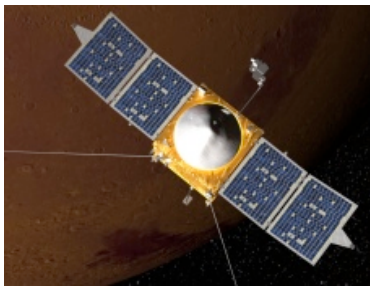


BepiColombo (ESA/JAXA)

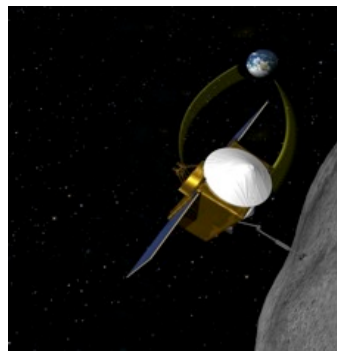
Planetary Data System Version 4

International, distributed, model-driven data architecture for capturing, managing and distributing planetary science data results to the world-wide science community.*

2000: 4 TBs; 2014: 720 TBs



MAVEN (NASA)



Osiris-Rex (NASA)



LADEE (NASA)



ExoMars (ESA)

* Endorsed by the **International Planetary Data Alliance** in July 2012 –

<https://planetarydata.org/documents/steering-committee/ipda-endorsements-recommendations-and-actions>



Thank You!

- **Contacts and Links:**

- *S. Hughes – steve.hughes@jpl.nasa.gov*
- *D. Crichton – dan.crichton@jpl.nasa.gov*
- *S. Martinez - Santa Martinez <santa.martinez@sciops.esa.int>*
- *E. Law – emily.law@jpl.nasa.gov*
- *S. Hardman – sean.hardman@jpl.nasa.gov*
- *D. Heather - Dave Heather <dheather@cosmos.esa.int>*
- *PDS4 Document Page: <https://pds.jpl.nasa.gov/pds4/doc/index.shtml>*